The second Paper read was—

2. *Voyage up the Darling and Barwan Rivers.* By W. R. RANDELL, Esq.

HIS Excellency Sir R. Macdonnell reports the successful navigation of the Darling by Mr. Randell, not only beyond Mount Murchison, but to a point 120 miles by land higher than Fort Bourke, or 1800 miles by water above the junction of the Darling and the Murray, or, altogether, 2400 miles by water above the sea mouth of the Murray. The same gentleman has from the first been one of the most enterprising and successful navigators of the Australian rivers. His small steamer, the *Mary Anne*, was the very first that undertook a voyage up the Murray, as, in 1853, it not only preceded the *Lady Augusta*, but also reached a higher point than that vessel. Great importance is attached by the Governor to Mr. Randell's recent expedition. That gentleman describes the river above Fort Bourke as even easier to navigate than below it. He was stopped, in about 29° 25′ S. lat. and 147° E. long., by a rapid of 8 feet fall in two or three hundred yards, a place where the Blacks have constructed numerous weirs of stone for capturing fish. He believes a passage through this might easily be made, and steamers warped up it, when another 100 miles would be open to navigation. The river banks are occupied by settlers, up to Mount Murchison. Beyond that point the country greatly improves as a sheep country. The timber is not so plentiful as on the Murray, but it is much superior in quality. The natives are numerous above Mount Murchison. Mr. Randell considers the navigation of the Darling could be largely improved with little difficulty, first by clearing its bed of snags, which might be done at once; and, secondly, by damming up the backwaters and constructing some locks.

COLONEL GAWLER, F.R.G.S., regretted that Sir Richard Macdonnell was obliged to stop short in his journey, for fifty or sixty miles to the north-westward of the point he reached was that mysterious river which Stuart described, in some places three miles wide, flowing from east to west. It must be an extraordinary river, for the breadth and volume of water indicated a long course. Its source was probably far away to the westward, and, judging from the observations of Eyre, the atmospheric indications seemed to lead to the conclusion that there was a well-watered country in that direction. The mountains of South Australia were primary, and probably the same formation reappeared in the interior, rising perhaps to still greater elevations than in the south. Then came the interesting question of where was the embouchure of that river? It was impossible that it should have a mouth upon the coast, and the probability was that there was a great inland sea into which it emptied itself. He was of opinion that these inland bodies of water once had their waste-pipe by Lake Torrens into Spencer Gulf. The Governor found a deficiency of surface-water over large tracts of country, but a great abundance pouring out in an extraordinary manner from

rounded hillocks. In all tertiary and in most secondary formations water was to be got by digging, and these hillocks reminded him of similar hillocks in Syria, which were evidently craters of extinct volcanoes, and which nature had turned into Artesian wells. The paucity of natives seen by the Governor was a remarkable circumstance, and one did not know how to account for it. Probably they were to be found congregated round the inland sea. In connection with the general subject, he had recently seen the interesting journal of Mr. Selwyn, the Government geologist of Victoria, in which he described the geological formation of Southern Australia and also the beauty of the scenery. There was not a more beautiful country in the world. The mountains were massed together and rose in a most picturesque manner to heights varying from 2000 to 3000 feet, indented by beautiful valleys and ravines. The mountains were covered to their very summits with magnificent stringy-bark forests, and the bases were covered with forests of the gum-tree—trees as large as any in our parks, filled with kangaroos and emus, and birds of the strange Australian character; altogether presenting a country in which, in travelling through it, you were more constantly than in any country, almost, inclined to say, "I should like to build a house there." Then, this beautiful scenery was connected with a beautiful climate. The heat was great in summer, but there was nothing oppressive in it. There was a large amount of ozone in the atmosphere. Even the marshes on the banks of the Murray were not unhealthy: surveying parties had lived by them for six and eight months together. Captain Pullen, of the *Cyclops*, was in the Murray reed-beds for nine and twelve months together without a single case of fever in his party. Here, then, was a country to which we might turn our eyes with satisfaction, and be delighted to fill it up with the surplus of our population; and he rejoiced that it was in the mind of the Governor and of many others to explore the interior and extend our knowledge of this beautiful country more and more until the whole should become a magnificent rest for civilised man.

The CHAIRMAN said, that in the communication which had been made by the Governor there had been so many references not only to the physical geography of the country, but to its geological structure, and they had been so particularly asked by the Governor to give some geological explanation of the origin of fresh-water springs, which occurred as oases at great distances from each other in this vast country, and by which springs alone we could hope to obtain communication with the northern portions of the continent, that he hoped his friend Mr. Jukes, who had been many years in the country, and for whose geological accomplishments he would answer, would state his ideas as to the origin of these fresh-water springs, and give a general view of the physical geology and saline deposits of that great country.

MR. J. BEETE JUKES said he would endeavour to give a slight general sketch of the geology of the country, as far as he knew it, and then endeavour to say something about the question of water-supply. The eastern coast chain was entirely composed of palæozoic rocks. No part of this chain south of Cape Melville was less than 2000 feet above the level of the sea, and there were ridges that rose occasionally to 4000 feet, and in the Australian Alps to within nearly 7000 feet. Again, the minor ranges that ran north and south through Victoria were in the same way composed of palæozoic rocks. The same was true of the north and south ridges which stretched from Western Australia, in the neighbourhood of King George's Sound up to the North-West Cape. With respect to the east and west ranges south of Port Essington, and which struck the coast about Cumberland Inlet, he believed they were also composed of palæozoic rocks. Certainly there was granite there in considerable masses, for Leichhardt mentioned the fact in his book. All the high grounds of Australia consisted of these older aqueous and igneous rocks. Now for the flat country: according to Eyre, all the way from South Australia to Western Australia there was an unbroken range of cliff, varying from 200 to

500 feet in height, so unbroken that it was only here and there that Mr. Eyre was able to scramble down some of the minor gullies, in order to supply himself with the water that oozed out just at the base. There was not a single river course nor a single valley which could give a channel to a river course between the palæozoic rocks of South Australia and the palæozoic rocks of Western Australia. Mr. Eyre described the geological formation of this great expanse always in the same terms, which proved that they were horizontal beds of tertiary rocks. He described them sometimes as chalk, and sometimes as oolite, with flints, and containing oyster and other shells. There was flat land on each side of the ridges of South Australia, likewise composed of horizontal tertiary rocks, as was the case also round Port Phillip. There was another expanse of flat land to the north of Western Australia running for hundreds of miles between North-West Cape and the hilly ground of Cumberland Inlet. The only information we had about it was derived from the marine surveys. No large river came out there; the coast was very low, fronted by sand-hills; and the view of the interior showed a great plain covered by salsolaceous plants. Coming next to the Gulf of Carpentaria, all the accounts agreed in showing that the land was very flat all round the head of the gulf. No fossils were ever found there, therefore it could not be said positively that these plains were tertiary; but this was known, that no large river came out anywhere round the Gulf of Carpentaria. Large river mouths were passed; but Leichhardt always said they were full of salt-water. There were certain rocks making the flat land about Port Essington, resembling lithologically the rocks on the opposite side of the continent, those round Port Phillip especially. Putting all these facts together—that wherever you found these flat lands, and could identify the rocks underneath them, you found horizontal tertiary rocks, and connecting these great flat plains, which we knew existed on these three parts of the coast, with the great plains of similar rock that Sturt passed over when he penetrated into the interior, and that in the plains about the junction of the Darling and the Murray you got similar tertiary rocks—it did seem to him in the highest degree probable that all the interior of Australia was a continuation of the same flat plain, made of the same horizontal tertiary rocks. These tertiary rocks were all more or less porous. The beds of limestone were tolerably thin, and interstratified with beds of sand, so that water would readily sink through them.

Next, as to the water that fell upon this ground. No doubt in certain seasons—he did not mean in certain parts of the year, but in certain groups of years—there were large falls of water over a great part of the country. Accordingly, after two or three wet years all the low lands would be saturated with water, either on the surface or beneath it. Lakes would then be filled with water, broad lagoons would be formed, and actual streams, occasionally, when great floods ran off the land. But this did not give any permanent supply of water or permanent navigable rivers. The water rushed off as a flood, formed a river for a time, and the remainder then sank below the surface. When once it sank to a considerable depth, where it was protected from subsequent evaporation, there would be a supply, which might be reached by digging wells; but it would be below the surface, not upon it. That the general character of the climate of the country showed this alternation of wet and dry periods he thought might be proved by going a little back into history. Tracts of country which were once covered with water were now dried up and converted into farms, and what were described as inland seas had disappeared when the country was visited by subsequent explorers. An instance of the uncertain nature of the rivers occurred to himself at Swan River, since in riding up the upper part of the Swan he had at one part a long reach of water on his left hand, and a few miles farther on he found a reach of water on his right hand, without having had to cross any water. He at first thought it was a second stream; but he remembered that he had a little way back ridden across a

gravelly hollow, which was no doubt the dried up bed of the river. This was the general character of the rivers, and it was quite possible that for several years you might take a steamer up the Darling 1500 or 1800 miles, nearly to its source, and that for the next ten years you would not be able to take a single boat up. This resulted from the want of elevation in the mountain ranges. The Murray River, which was always navigable and a perpetually flowing stream, took its rise from the Australian Alps, the summits of which were covered for the greater part of the year with snow, the melting of which kept up a constant supply of water. Still, even with this river it was only occasionally that you got an opening into it from the sea. The mouth was blocked up with sand, and there was not a greater depth than three feet over it, the drainage of that part of the country not being sufficient to keep the mouth of the river open, as it would do in a country where there was a regular fall of water. He did not believe with Colonel Gawler that Lake Torrens was only the ancient embouchure of the streams he had mentioned, but the present one, and the only one it ever had, and that no more water had ever come out on an average of years than came out now. These facts proved to him that there could not be a well-watered country over the whole of the interior of Australia. There might be large oases; but generally it must be a dry country, or else the overplus of drainage would come out in considerable rivers somewhere. The fact mentioned by Gregory that after ascending the basin of the Victoria and crossing the water-parting at no greater height than 1400 feet, he soon came down upon salt lakes, proved that it was an arid country, in which the evaporation was greater than the waterfall, or the lakes would not have been salt.

The springs mentioned by Sir Richard Macdonnell were very curious and interesting, and he was for some time puzzled by them. It appeared to him that the water must contain a great quantity of carbonate of lime in solution, and that these cups were nothing more than calcareous tufa that had been deposited gradually by the overflow of the spring, until finally the deposit made a mound, through which the water continued to well out, just as in the case of the siliceous mounds round the geysers in Iceland.

The third Paper read was—

3. *On Typical Mountain Ranges.* By William Spottiswoode, Esq., F.R.G.S.

In an elaborate memoir published in the 'Petersburg Transactions,' Series VI. tom. viii., Dr. Abich has grouped the mountain ranges of Western and Central Asia under four heads, and deduced a mean direction for each group; but in doing so he has simply taken the arithmetical mean of the direction of the ranges under consideration, without reference to their length or their elevation. Mr. Spottiswoode shows the method by which the calculation of a mean direction ought justly to be made; not only by taking these omitted data into account, but also by using the calculus of probabilities to find whether or no, that mean direction be a *typical* one. Mr. Spottiswoode's object is not so much to correct Dr. Abich's conclusions on this particular point, which are, in fact, independent of the largest